Regional Health Assessment relating to mercury content of fish caught in the Yukon-Kuskokwim Delta rivers system

Lawrence K. Duffy[1]
Tauni Rodgers[2]
Molly Patton[2]

ABSTRACT

Seven species of fish were surveyed for muscle tissue mercury content across a broad area of western Alaska. Total mercury levels were determined by cold vapor atomic fluorescence spectroscopy in 66 fish sampled during 1997. Methylmercury in sampled fish amounted to 97 to 100% of total mercury values. Using mercury consumption risk levels derived from U.S. Environmental Protection Agency hazard assessment models, mean total mercury was determined to be above the human critical value of 0.2µg/g (ppm) in 29% of the fish species, and 62% of the fish species contained mercury exceeding the wildlife critical value for piscivorous mammals. Overall, 24% of the fish exceed the critical value for human consumption and 58% the wildlife critical value. Similarly 31% of sites sampled exceeded the human consumption critical value. Based on the mean of all fish sampled and a small number of river otters, a biomagnification factor of 12 was calculated for the Yukon-Kuskokwim Delta Region of Alaska.

(1) Institute of Arctic Biology, Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, AK 99775.
(2) Office of Environmental Health and Engineering Yukon-Kuskokwim Health Corporation, Bethel, AK 99559.

Correspondence and Reprints to:
Dr. Lawrence K. Duffy
Institute of Arctic Biology
University of Alaska Fairbanks
Fairbanks, AK 99775
Tel: 907-474-7525

INTRODUCTION

Total mercury concentrations (Hg) in fish tissues are of special concern because of the potential of MeHg to biomagnify through the food chain in aquatic ecosystems. Mercury, as methylmercury (MeHg) in fish, represents a potential risk to wildlife consumers such as piscivorous birds (e.g. eagles and loons) and mammals (e.g. mink and river otters) and possibly to the fish themselves. In Alaska, studies have found Hg in common loons blood and feathers (1). The levels reported may exceed those associated with reduced reproduction in eagles (2). Within the human population, cognitive defects in children with low level prenatal exposure to methylmercury has been reported (3). Sports fisherman and subsistence users, as well as their children, now run the risk of neurotoxical effects. Because of the human health effects and ecological implications, a board sampling survey of fish muscle was begun in 1997 in Alaska. In this report, we compare our initial results with suggested critical values (4).

MATERIALS AND METHODS

A combined total of 66 fish were sampled for mercury. The collection sites were distributed throughout the Yukon-Kuskokwim Delta region as chosen by subsistence users. Fish were collected by multiple collection methods. At the laboratory in Bethel, Alaska, fish were stored at -20 C until dissected and sent to Frontier Geosciences (Seattle, WA) for analysis. Hg was analyzed by cold vapor atomic fluorescence spectrophotometry (CVAF) after samples were digested with acid (5).

Regional assessment was conducted by comparing the means of individual species or river location sites with critical values. Critical values used in the analyses were those reported by Yeardley et al. (4).

We also used a recent review of mercury risk assessment (6) to obtain FDA standards. Elemental Hg concentrations were used for MeHg (the more neurotoxic form) because it has been shown that 95 to 100% of the Hg in fish tissue was in the form of MeHg (7). A small subset of our samples were also analyzed for MeHg and the mean for the MeHg species was 96% of the total Hg with a range of 76 to 100% of the total Hg in the MeHg form. When the method of Bloom (7) is used, the upper range increases to 112% and the mean MeHg is 101%.

RESULTS

The mean MeHg levels in fish from the Yukon-Kuskokwim Delta region of Alaska was 0.226 µg/g. These fish had overall mean lengths of 17.6 inches. There was a general trend that the larger the fish within a species group, the higher the MeHg content. Table 1 and 2 list the means and standard deviations of the measured MeHg levels for both the individual species and the individual sampling sites with combined species. Sixteen fish (24%) in the Yukon-Kuskokwim Delta sample exceeded 0.2 µg/g critical value for MeHg and 38 (58%) of the fish had levels higher than the 0.1 µg/g critical value. The 0.1 µg/g is the lowest legal limit in the world with 1 out of 26 countries surveyed using this value. The most common worldwide legal limit is 0.5 g/g. Only 9% of the fish exceeded this legal limit.

Using these critical values, percentages of individual species and individual sites showed widespread occurrence of MeHg and that the distribution was not confined to one subregion (Table 3). 85% of

Table 1. Mean Mercury Levels in Y-K Delta Fish Species

Species	Hg mean (µg/g)	SD	n	Human CV (.2 µg/g)	Animal CV (.1 µg/g)	Sensitive CV (.05 µg/g)
Dolly Varden	.017	.022	15	-	-	-
Grayling	.144	.053	12	-	+	+
Burbot	.100	.048	5	-	+	+
Pike	.718	.578	13	+	+	+
Sheefish	.226	.151	5	+	+	+
Suckerfish	.087	.042	3	-	-	+
Whitefish	.132	.084	13	-	+	+

Table 2. Mean Mercury Levels in Y-K Delta Fishing Sites

Site	Hg mean (µg/g)	SD	n	Human CV (.2 µg/g)	Animal CV (.1 µg/g)	Sensitive CV (.05 µg/g)
Andrefski R.	1.068	.803	3	+	+	+
Bethel	.089	.021	4	-	+	+
Emmonak	.155	.181	7	-	+	+
George R.	.270	.397	9	+	+	+
Goodnews R.	.107	---	1	-	+	+
Gweek	.178	---	1	-	+	+
Johston R.	.140	.047	4	-	+	+
Kanektok R.	.064	.081	17	-	-	+
Kogrukluk R.	.096	.045	5	-	-	+
Kuskokug	.206	---	1	+	+	+
Kwethluk	.159	.089	5	-	+	+
Piamute	.813	.451	5	+	+	+
Tuluksak R.	.101	.039	4	-	+	+

Table 3. Percentage of Category Above Critical Value

Category	Legal Value (.5µg/g)	Human Critical Value (.2µg/g)	Animal Critical Value (.1µg/g)
Species	14.3%	28.6%	62.5%
Sites	15.3%	31%	85%
Individuals	9%	24%	58%

the sites exceeded the 0.1µg/g critical value and 100% were above the critical value for sensitive populations with heavy consumption (0.05µg/g). For individual species 62% exceeded the animal CV (health risk for wildlife).

Biomagnification is a process where there is an increase in concentration from one trophic level to another due to the accumulation of contaminants in food (9). If the MeHg concentration of a predator, e.g. river otters is known, than a biomagnification factor for river otters in the Yukon-Kuskokwim Delta region can be calculated from the mean MeHg levels in the fish. This factor was 12 for Yukon-Kuskokwim Delta. This factor is about one third of the biomagnification factor observed in Prince William Sound.

DISCUSSION

Monitoring studies in the lower 48 states have found fish tissue MeHg to be widespread at levels similar to these Yukon-Kuskokwim regional levels (4). Over 50% of fish consumption advisories in the United States are for Hg (8). Similar to data reported in Maine's REMAP study where Hg was detected in 99% of the samples, we detected Hg in 100% of our samples (4). However, in comparing MeHg results of various studies, it is important to note fish sizes. Since our mean length was 17.6 inches, we may be dealing with a sample of larger fish. For example, Bloom's (7) reported range for pike was similar to this study but our mean was higher.

Average total Hg concentration in bass, crappie, dolphin, halibut, mackerel, pike, snapper and tuna range from 0.2 to 0.3µg/g (6). Our mean of 0.23 ppm would provide close to EPA reference dose (RFD) if an average woman consumed about 5 ounces of fish per week. Egeland and Middaugh (6), however, caution about the simple application of the EPA's RFD. They point out the benefits from protein and omega-3 polyunsaturated fatty acids as well as the lack of appropriate toxicity studies at these low levels. By continuing to monitor Hg levels in different regions of Alaska, we hope to have solid data for risk assessment when the results of toxicity studies become more definitive.

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perience available. It is not unreasonable to expect that their efforts, as well as those of *Dr. Paul Isaak* in Soldotna, will help provide a continuing supply of qualified physicians for Alaska, in addition to enriching the curriculum and medical understanding of the students involved.

We hear that federal funds have been granted to assist in the completion of a new 12 bed hospital here.

PORTLAND, OREGON

Morningside Hospital has apparently closed recently. It will be recalled that Alaskan patients were withdrawn last year to Alaskan facilities after many years of using Morningside for chronic in-patient hospital care.

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Recently the Office of Environmental Health and Engineering has received inquires concerning recently publicized levels of mercury found in fish samples in the Yukon-Kuskokwim rivers. Mercury has always been present in the environment. Mercury can be found in the environment by: 1.) Global distribution of industrial wastes through the atmosphere and 2.) point sources, such as erosion of geological deposits and mining activity.

To ease concerns about our subsistence fish, here are some preliminary findings from the study conducted by OEHE and Dr. Duffy at the University of Alaska Fairbanks.

Of the 66 fish that were sampled, 18 (mostly pike) were found above the .2 parts per million level of concern set by the Environmental Protection Agency (EPA). But, these results are much lower (five times lower) than the Food and Drug Administration (FDA) standards and lower than most mercury levels of fish found in the lower 48 states. Dr. Duffy indicates that a diet consisting of large fish eaten twice a week is not a cause for concern.

The main concern in recently published reports are mercury's effects on a developing fetus. The most sensitive time is during the first three months of pregnancy (first trimester). Dr. Duffy doesn't have a problem with a pregnant woman eating pike but he does not recommend her eating large, pike 7 days a week.

It is not known how much mercury is passed on to humans. There is likely a positive effect from eating fish oils. Studies have shown fish oils block the uptake of mercury. There are many interactions between diet and mercury absorption, with fish protein, vitamin E, and vitamin C possibly modifying the toxicity.

If you would like to send in whole fish or 1 inch sections of river otter fur to be sampled for mercury, please feel free to call our office at 1-800-478-6599 to make arrangements for shipping.